Please check that this question paper contains__9____ questions and ____3__ printed pages within first ten

[Total No. of Questions: 09] [Total No. of Pages: .....]

Uni. Roll No. .....

Program: B.Tech. (Batch 2018 onward)

Semester: 3rd

Name of Subject: Thermodynamics

Subject Code: PCME-101.

Paper ID: 16072

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3 0 DEC 2022

Time Allowed: 03 Hours **Max. Marks: 60**

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NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choices
3) Any missing data may be assumed appropriately
4) ***Steam Table must be provided by Examination Centre***

Part – A **[Marks: 02 each]**

Q1.

a) State the First Law of Thermodynamics as referred to cyclic closed systems.
b) Determine the Carnot cycle efficiency for temperatures 277°C and 16°C.
c) State Zeroth law of Thermodynamics with its physical significance.
d) Define the terms Phase and Pure substance.
e) What do you mean by Quasi-static process? Give suitable examples.
f) Classify different types of fuel.

Part – B **[Marks: 04 each]**

Q2. 85 kJ of heat are supplied to a system at constant volume. The system rejects 90 kJ of heat at constant pressure and 20 kJ of work is done on it. The system is brought to its original state by adiabatic process. Determine the adiabatic work. Determine also the values of internal energy at all end states if initial value is 100 kJ.

Q3. Discuss the important features that distinguish Spark Ignition and Compression Ignition internal combustion engine.

Q4. Find the enthalpy, internal energy and entropy of 1 kg of steam at a pressure of 10 bar;
(i) When steam is dry saturated
(ii) When steam is 0.75 dry
(iii) When steam is superheated to 250^0C
Use steam tables and neglect volume of water.

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Q5. Derive an expression for air standard cycle efficiency of Otto Cycle.

Q6. Air enters a compressor operating at steady state at a pressure of 1 bar, a temperature of 290 K, and a velocity of 6 m/s through an inlet with an area of 0.1 m^2. At the exit, the pressure is 7 bar, the temperature is 450 K and velocity is 2 m/s. Heat transfer from the compressor to its surroundings occur at a rate of 180 kJ/min. Calculate the power input to compressor in kW. Take enthalpy at inlet = 290.16 kJ/kg and enthalpy at outlet = 451.8 kJ/kg.

Q7. The analysis of the coal in a boiler trial was C - 81%, H_2 –5%, O_2 – 5 %, moisture 2 %, and ash 7 %.
(i) Calculate the mass of air required for complete combustion of 1 kg of fuel.
(ii) Calculate the volumetric analysis of dry flue gases, if actual air supplied is 16 kg per kg of fuel.
Assume 80% of carbon is burnt to CO_2 and remaining to CO

Part – C **[Marks: 12 each]**

Q8. **(a)** Air at 30°C and 1bar is compressed reversibly and polytropically from 5 m^3 to 1m^3. Calculate the final temperature, pressure and also work done and heat transferred if index of compression is 1, 1.4 and 0.9 respectively. Assume C_P = 1.005 kJ/kg K and C_V = 0.7178 kJ/kg K. **[6]**

(b) Air enters the compressor of an Ideal air standard Brayton Cycle at 100 kPa, 300 K with volumetric rate of 5m^3/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1400 K.The turbine and compressor each have an insentropic efficiency of 80 %. Determine for the modified cycle (a) the thermal efficiency of the cycle (b) the net power developed in kW. **[6]**

OR

(a) Steam enters a turbine with a pressure of 30 bars, a temperature of 400°C, and velocity of 160 m/s. Saturated vapor at 100°C exists with a velocity of 100 m/s. At steady state, the turbine develops work equal to 540 kJ/kg of steam flowing through the turbine. Heat transfer between the turbine and its surrounding occurs at an average outer surface temperature of 350 K. Determine the rate at which entropy is produced within the turbine per kg of steam flowing in kJ/kg. Neglect the change in potential energy between inlet and outlet. **[6]**

(b) Distinguish between Heat Engine, Refrigerator, and Heat Pump **[6]**

Q9 Considering a regenerative vapor power cycle with open feed water heater, steam enters the turbine at 8.0 MPa, 480°C and expands to 0.7 MPa, where some of steam is extracted and diverted to the open feed water heater operating at 0.7 MPa. The remaining steam expands through the second stage turbine to the condenser pressure 0.008 MPa. Saturated liquid exits the open feed water heater at 0.7 MPa. The isentropic efficiency of each turbine stage is 85 % and each pump operates

isentropically. If the net power output of cycle is 100 MW. Determine (a) the thermal efficiency of cycle (b) the mass flow rate of steam entering the first stage turbine is kg/h. **[12]**

OR

A Reheat cycle with two stages of Reheating (TWICE REHEATING) is performed with expansion commencing from 210 bar and 550°C. The reheater pressures are 41 bar and 10 bar. The exit of steam from both the reheaters is at 550°C and condensing temperature is 50°C. Determine (a) the heat supplied and (b) thermal efficiency of cycle. Show on T-s as well as on h-s diagrams. **[12]**

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